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VARIATION OF SLENDERNESS RATIO IN BLACK POPLAR (*Populus nigra* L.) ROAD ALIGNMENTS

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Abstract: *The slenderness ratio indicates the spatial distribution of the trunk biomass. Given to the very important role of the slenderness ratio in maintaining the stability of trees, the variation of this parameter in a road alignment consisting of black poplar trees, was investigated. The analysis of the total tree height and of the diameter at breast height, in relation to slenderness indicated a rather low influence. Therefore, the value of the slenderness ratio for the analyzed trees is determined, in particular, by the growing and development conditions. Since the value of the slenderness ratio varied between 31 and 50 for the vast majority of the poplar individuals, (84%) it can be concluded that the stability of trees is ensured along the road alignment.*

Key words: *slenderness ratio, stability of trees, alignments of trees.*

1. Introduction

An important parameter when assessing the stability of a tree in relation to wind and snow is the slenderness ratio [6], [9–12], [13], [15–17]. Beldeanu (1999) has mentioned that the slenderness ratio, the stem straightness, the natural-pruning capacity and the crown shape are genetically controlled characters, although the environment influences their development [2].

Therefore, the shape of the trunk in longitudinal section is a consequence of the interaction between genotype and environment [2] and [8] and it differs from species to species. For a given species, it varies with the age, stand's density and site-specific conditions [2].

This paper aims to examine the influence of the slenderness ratio on the stability of the trees and to check to what extent the characteristics of the trees affect the values of the slenderness ratio.

2. Materials and methods

2.1. Study location

This study was carried out in Brasov county, in an alignment of black poplar (*Populus nigra* L.) located at a distance of about 30 km from Braşov city, near the E60 road. The Măieruş corridor, respectively the area where the studied

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alignment was located, is an individualized unity of Braşov lowlands. It lies between Feldioara and Augustin [5] and it is characterized, from the climatic point of view [1], by an annual average temperature ranging from 7.1 to 7.6°C, by precipitations between 500 and 580mm and by dominant winds blowing from North – East and North – West.

2.2. Research methodology

In this study, the biometric characteristics (breast height diameter and height) and the pruned height of 163 black poplar trees were measured and analyzed.

The used equipment was specific. The diameters were measured using a forestry calliper, while the heights and the radii of the crown were measured using a TruPulse TM 200 laser rangefinder.

Based on the field measurements, the crown length was calculated as the difference between the total height of the tree and the insertion height of the first live branch that marked the base of the crown [6] and [14]; the pruned height [3], [7] and [9] was calculated as the difference between the total tree height and the crown length .

The methodological approaches, including the measured features of the crown are described in detail in Fig. 1.

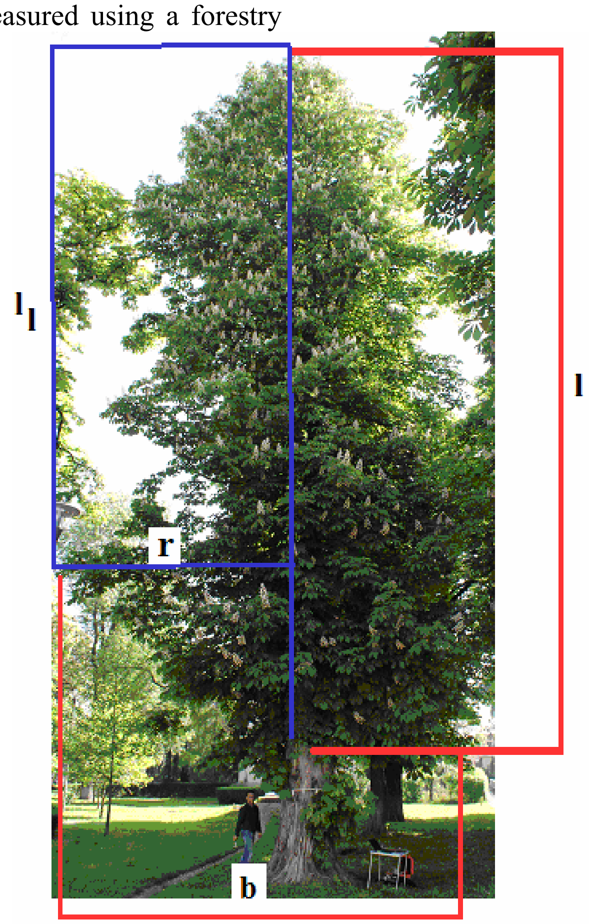

Fig. 1. *Measurement of a tree crown, where: l –crown length; r – crown radius; b – crown diameter; l_l – crown length in light.* [Photo: Muşat E.]

The resulted datasets were statistically analyzed mainly by using descriptive statistics such as: the mean, median, minimum and maximum value, variance, standard deviation and coefficient of variation.

The possible dependence relations between the slenderness ratio (that was considered a response variable), the total tree height and the diameter at breast height respectively (that were considered predictors) were checked by-using the least square simple linear regressions technique.

3. Results

The heights of the analyzed trees ranged from 6.8 to 27.4m, averaging 19.3m, while the breast height diameter ranged from 29 to 74cm, averaging 47cm. After grouping the height data on classes, it was found that most of the trees (71 individuals – 43%) had a height between 15.1 and 20m, being followed by 63 trees (38%) with the height between 20.1 and 25m and by 17 trees with the height lower than 15m. On the other hand, the frequency distribution of the breast height diameter indicated that 86 trees (53%) had a diameter between 40 and 50cm, while 37 trees (23%) had diameters between 50.5 and 60cm.

The pruned height varied between 1.6 and 5.5m, with a significant data grouping in the range 1.9 – 2.5m (118 trees – 72%); a fact that, along with the values of the tree crown height, which were close to that of the tree height, may be explained by the general characteristics of the studied trees that were located in an open field at relatively large distances from each other.

The slenderness ratio varied between 17 and 61 (Table 1). The regression statistics (the determination coefficient, in particular) indicated that the influence of the chosen predictors (the total height of the tree and the diameter at breast height) was rather low (Fig. 2). Therefore, we can assume that the value of the slenderness ratio is determined, in particular, by the growing and development conditions.

The descriptive statistics of the slenderness ratio are shown in Table 1, in terms of breast height diameter categories.

It was also noted that the highest mean value (42.85cm) was found for the diameter class of 40.5 – 50cm, while the lowest mean value (35.58cm) corresponded to those trees having diameters larger than 70cm. In addition, it appears that the highest and lowest values of the standard deviations and of the variation coefficient–corresponded to the same categories of diameters.

Statistical indicators for the slenderness ratio Table 1

Breast height diameter classes (cm)	Average (cm)	Median (cm)	Value		Variance (cm^2)	Standards deviation (cm)	Coefficient of variations
			Minimum (cm)	Maximum (cm)			
30 - 40	42,10	46,03	17,22	56,11	131,85	11,48	0,27
40,5 - 50	42,85	43,59	22,00	60,96	47,95	6,92	0,16
50,5 - 60	39,06	37,33	29,65	51,84	33,31	5,77	0,15
60,5 - 70	36,62	35,81	32,41	44,92	17,29	4,16	0,11
70,5 - 74	35,58	36,42	32,30	37,18	5,25	2,29	0,06

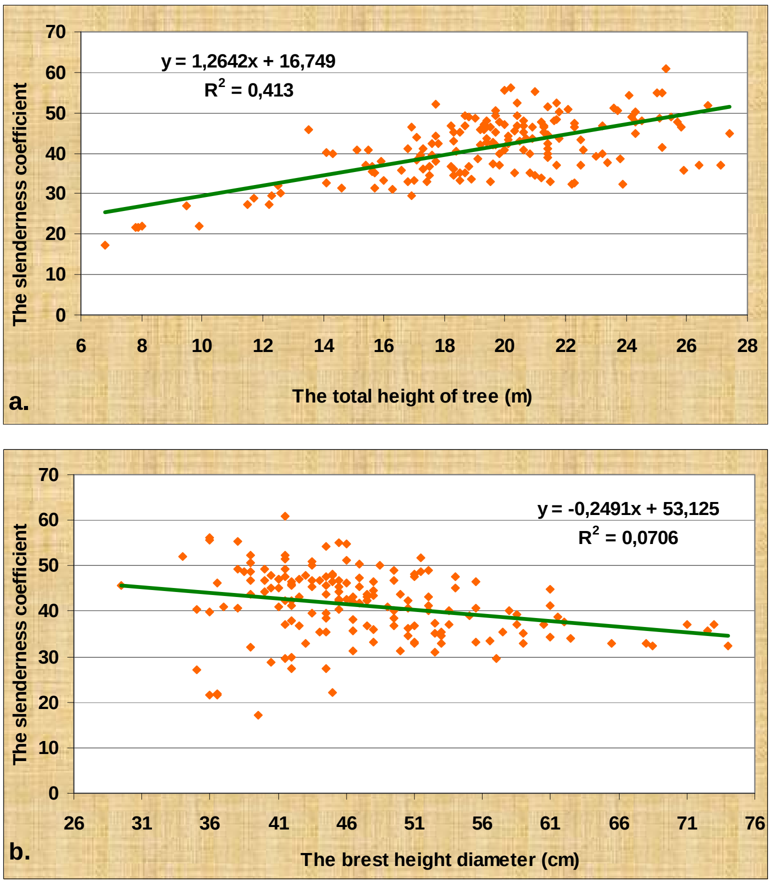

Fig. 2. *Dependence relations between the slenderness ratio and the total height of the tree (a.), respectively the diameter at breast height (b.)*

4. Discussion

According to the literature [12] and [17], the fall or fracture risk increases by the increasing tree height and slenderness ratio, so that at heights above 20m and at slenderness ratios above 120, the highest risk [12] occurs.

After studying an even-aged stand from Mexico, [6] mentioned that the obtained slenderness ratio values (41... 42) indicated a stable stand.

On account of this finding, in the case of studied black poplars, one can infer that the tree stability is ensured, because 84% - most of them – had the slenderness ratio between 41 and 50 (48%), and between 31 and 40 (36%).

On the other hand, when suddenly exposed to the perturbing action of the wind, the trees from inside the forest, as well as the trees located on recently created tree lines are proner to damages produced by wind, than the trees that have grown at the edge of forest stands for a long period of time [17]. This is because they have formed some characteristics that make them stable (lower slenderness ratios and a rooting system better developed). If these mentions are considered, as well as the conditions of growth and development, which are specific to tree alignments, it can be said, once again, that the studied trees are stable to the perturbing action of the wind.

5. Conclusions

In direct relation to the influence of the slenderness ratio on the stability of trees, and by comparing the results of this study with those reported by other studies, it can be said that the studied black poplars have developed their crowns in a large proportion from their height (that reduced slenderness ratios), have conical trunks and well developed rooting systems. All these features give them a good behaviour in their relation to destabilizing factors, especially to wind.

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